UDC 330.341.1:351.82

National Innovation System as a Focus of State Innovation Policy*

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SUMMARY. The article offers a systematic review of tools and mechanisms utilised by developed countries (United States, Japan, EU) to pursue their innovation policies, and classifies methods which support innovation and ways that help to strengthen the innovation capacity. It describes the evolution of research and development (R&D) policy in other countries. The article examines arguments in support of a trend in the innovation policy which promotes the development of national innovation systems. It reviews the substance and components of the national innovation system. It also explores the trends of R&D cooperation. The article outlines the variety of domestic tools which regulate innovation in EU countries (framework programs, the European Research Area Initiative).

KEY WORDS. National innovation system, innovation capacity, innovation policy, government innovation incentives, tax incentives, tax credit, accelerated depreciation, subsidies, grants, research and development (R&D) cooperation, framework research development programs, European Research Area.

Introduction

In the last decade, globalisation has become an intrinsic factor of the world's economic development. It manifests itself in a growing economic interdependency of various countries around the world due to an increasing and more dynamic trans-border movement of goods, services, capital, and labour resources and due to accelerated diffusion of technology. The dominating trend in the world economic architecture today is the intellectualisation of social production factors, which gives some unique long-term competition advantages. The developed countries have based their innovation models of economic development on intensive production and new knowledge. The use of these models in education, technology, industrial management and goods allows them to achieve 70 % to 85 % of GDP growth today. The favourable impact of innovations on the competitiveness of the national economy can be seen in the growing labour productivity and value added, structural renovation of the economy, greater share of hi-tech and science-driven industries in

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* This article was translated from its original in Ukrainian.

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production and exports, increasing quality of products and, as the result, expanding sales markets.

An effective innovation model of economic development can only be formed by establishing a mutually beneficial partnership of the government and the business, a combination of public and corporate interests, and creating a business environment that facilitates innovation. In most countries of the world, support and stimulation of development and commercialisation of new technology are officially recognized as a cornerstone of national competitiveness strategies and a priority of the national economic policy.

The issues of setting up innovation models of economic development, studying the impact of innovations on economic growth and labour productivity, and developing the mechanisms that allow to achieve innovative competition advantages are seriously examined in the present-day scientific literature. They have been addressed in the works of many foreign scholars, including M. Abramovitz, W. Baumol, S. Glaziev, E. Denisson, C. Edquist, N. Ivanova, L. Kantorovich, B. Lundvall, G. Mensch, R. Nelson, Y. Park, P. Romer, B. Santo, D. Sakhal, R. Solow, B. Twiss, S. Winter, R. Foster, C. Freeman, J. Furman, F. Sherer, J. Schumpeter, etc. The issue of an efficient foreign economic strategy for Ukraine based on an innovation model of economic development has been examined by such Ukrainian scholars as V. Aleksandrova, L. Antonyuk, Yu. Bazhal, O. Bilorus, A. Halchynsky, V. Heyetz, Ya. Zhalilo, B.Kvasniuk, N. Krasnokutska, D. Lukyanenko, S. Mocherny, Ye. Panchenko, Yu. Pakhomov, A. Poruchnyk, A. Rumyantsev, V. Savchuk, S. Sokolenko, A. Sukhorukov, O. Shnypko, T. Schedrina, etc.

However, not all aspects of this academic problem have been sufficiently studied in the contemporary academic literature. In particular, such issues as effective government support of innovation, diversification of funding sources for scientific research, development of modern innovation infrastructure, systemic approach to and effectiveness of innovation processes are quite important at both methodological and applied level. Therefore, reviewing and adapting the best world practices in the development and implementation of innovation policy is an important process that helps to facilitate Ukraine’s innovation development, create an efficient national innovation system and achieve technological competitive advantages. These issues are addressed in this article.

Methodological Approach to the Study of National Innovation Systems

The historical review of the innovation process by a famous researcher R. Rothwell has demonstrated that the innovation development has sustained an evolution from simple linear models to more complex non-linear models.[1]

The former approach (from1950 to mid 1960s) viewed the innovation process as a linear sequence of scientific research, development, production and marketing. This concept is known as a technology-push in the literature. Its proponents, M. Tuhan-Baranovsky, J. Schumpeter, C. Freeman, N. Rosenberg, R. Nelson, A. Philips and others, argue that it is the scientific and technological conditions which give start to the innovation process.[2]

The demand-pull paradigm emerged in late 1960s. The advocates of this approach, J. Schmookler, G. Mensch, E. von Hippel and others, contended that the market demand is the key factor of innovation[3]. Therefore, with the linear model, applied research and development triggers new opportunities and improvements which find their way into the market, or the market signals of its new demands.[4]

Later, from the early 1970s to mid 1980s, the two previous approaches merged and gave birth to a model of interaction between technological possibilities and market demand, which takes into account the interrelation between various elements of innovation process. In particular, the studies have shown that the shares of technological innovation driven by demand or scientific development in the United States are 70 % and 30 %, respectively.[5]

A parallel model emerged in the mid 1980s which describes a company's integration with its suppliers and customers. Strategic integration has been the dominant model since the 1990s. According to that model, a company engages in a continuous innovation process based on a flexible response to the changing environment. The typical characteristics of that model include a close interaction of all market players, growing importance of feedback between producers and consumers, change of the traditional sequence of stages in the innovation research cycle, growing role of research and development cooperation, and the growing flow of knowledge and technology among participants of the innovation process.

Therefore, today's innovation model is a non-linear model: innovation players engage in a complex system of interaction, which requires a high

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1 *Rothwell R.*, Successful industrial innovation: critical success factor for the 1990s, in *R&D Management*, 1992, Issue 22(3), p. 221—239.

2 Dlinnye volny: NTP I sotsialno-ekonomicheskoye razvitiye *(Long waves: STP (Science and Technology Progress) and social and economic development)*, by Glaziev S. Yu. et al, Novosibirsk, Nauka, 1991. — P. 94—97.

3 Dlinnye volny: NTP I sotsialno-ekonomicheskoye razvitiye *(Long waves: STP (Science and Technology Progress) and social and economic development)*, by Glaziev S. Yu. et al, Novosibirsk, Nauka, 1991. — P. 99—100.

4 *Antoniuk L. L., Poruchnyk A. M., Savchuk V.S.* Innovatsiyi: teoriya, mechanism rozrobky ta komertsializatsiyi *(Innovations: theory, development and commercialization mechanism)*, a monograph. — K.: KNEU, 2003. — P. 28.

5 *Kuteinikov A. A.* Iskustvo byt novatorom: Mirovoy opyt riskovogo biznesa *(The art of being an innovator: world experience of business risks)*. — M.: Znaniye, 1990. — 64 p.

level of integration not only within a company but also at the inter-company and even inter-industry and cross-sectoral (education-science-industry) levels.

Until the 1980s, most countries utilised the traditional regulation of innovation, which failed to take into account the specific nature of technological change. Such a policy was dictated by the then-dominant neoclassical theory and simplified understanding of innovation process as a one-way chain of cause-and-effect relation: creating intellectual resources as items of intellectual property — implementing them in the industrial production — marketing of innovation products made on the basis of original items of intellectual property. The major focus was on the government support of basic research coupled with intensive competition and legal protection of intellectual property. However, a tough competition on the domestic market results in the domination of pricing tools which regulate competition and leads to the development of resource and labour intensive industries with traditional technologies.

The experience of many countries has demonstrated that the linear model was in conflict with changes in the mechanisms of competition and proliferation of modern parallel and integrated system models of innovation management at the company level. This situation demanded a review of the theoretical framework for regulating innovation at the level of the entire economy.

A new paradigm, which was based on the systemic understanding of innovation process and takes into account non-linear ties between innovation actors, emerged from the neo-institutional approach to economic theory in the late 1980s. The works of B. Lundvall,[6] C. Freeman[7] and R. Nelson[8] laid the theoretical basis of the national innovation system (NIS) approach. The focus of the NIS theory is on the study of relationships among actors of the innovation process within national economies, and the impact of formal and nonformal rules of conduct on the flow of technology and information among them. The proponents of the NIS theory proceed from the assumption that innovation and technology development are results of a complex set of relationships among actors involved in the NIS, including enterprises, universities and government research institutes. In contrast to the linear approach, they argue that the general innovation efficiency of the economy depends not only on the efficiency of individual actors of the innovation process (research and development institutes, innovative enterprises, etc.) but also on the nature of their interaction in the course of creation and dissemination of new knowledge. The competitiveness of a country depends on the efficiency of the NIS.

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6 National Innovation Systems: Towards a Theory of Innovation and Interactive Learning, Ed. B-Å. Lundvall, London: Pinter, 1992, 317 pages.

7 *Freeman C.* The National System of Innovation in Historical Perspective, in *Cambridge Journal of Economics*. — 1995, Issue 19 (1), February, p. 5—24.

8 National Innovation Systems. A Comparative Analysis / Ed. R.R. Nelson, New York: Oxford University Press, 1993. — 560 p.

C. Freeman defines the national innovation system as «the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies»[9].

Therefore, a national innovation system incorporates two major components[10]:

— *organisations*, which are with an explicit purpose and they are consciously created. They are the main actors of the innovation process. They particularly include universities, research and development organisations, venture capital organisations and public innovation policy agencies; and,

— *institutions,* which are sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups and organisations in the course of innovation.[11] They shape the mechanisms of interaction among actors within the innovation system and create conditions for accelerated diffusion of knowledge and technology among them, what, in our opinion, determines the overall efficiency of the NIS.

Therefore, a set of organisations and mechanisms — which shape the conditions for the creation, storage, diffusion and industrial application of scientific and technical knowledge in a country — form its national innovation system.[12] The main elements of the national innovation system include the following subsystems: generation of new knowledge; education and professional training; products and services; innovation infrastructure including financial support.[13]

Taking into account that the NIS operates in conditions of a market economy and within a specific country, other elements of the NIS may also include markets (intellectual property, high tech products and services, and

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9 *Freeman C.* The National System of Innovation in Historical Perspective, in *Cambridge Journal of Economics*, 1995, Issue 19 (1), February. — P. 5-24.

10 *Fedirko O. A.* Natsionalni innovatsiyni systemy krayin vysokoho konkurentnoho statusu, in Upravlinnia mizhnorodnoyu konkurentnospromozhnistiu v umovakh globalizatsiyi economichnoho rozvytku *(National innovation systems of countries having high competitive status, in international competitiveness management counselling in the conditions of globalization of economic development)*, a monograph in 2 volumes, V. 1, D.G. Lukianenko, A.M. Poruchnyk, L.L. Antoniuk et al.; Ed. by D.G. Lukianenko, A.M. Poruchnyk. — K.: KNEU, 2006. — P. 679.

11 *Edquist C.* The Systems of Innovation Approach and Innovation Policy: An account of the state of the art, Lead paper presented at the DRUID Conference under theme F: «National Systems of Innovation, Institutions and Public Policies», Aalborg, 2001. — P. 5.

12 *Fedirko O. A.* Natsionalni innovatsiyni systemy krayin vysokoho konkurentnoho statusu, in Upravlinnia mizhnorodnoyu konkurentnospromozhnistiu v umovakh globalizatsiyi economichnoho rozvytku *(National innovation systems of countries having high competitive status, in international competitiveness management counselling in the conditions of globalization of economic development)*, a monograph in 2 volumes, V. 1, D.G. Lukianenko, A.M. Poruchnyk, L.L. Antoniuk et al.; Ed. by D.G. Lukianenko, A.M. Poruchnyk. — K.: KNEU, 2006. — P. 679.

13 *Bunchuk M.* Natsionalnye innovatsionnye sistemy: osnovnye ponatiya i prilozheniya *(National innovation systems: basic concepts and applications)*, Moscow, Analiticheskiy tsentr po nauchnoi i promyshlennoi politike (Analytical Center for scientific and industrial policy), 1999, www.geocities.com/CollegePark/Lab/5590/nis.htm

production factors, including workforce), as well as the innovation regulatory system and macroeconomic innovation policy[14] (Fig. 1).

NATIONAL INNOVATION SYSTEM

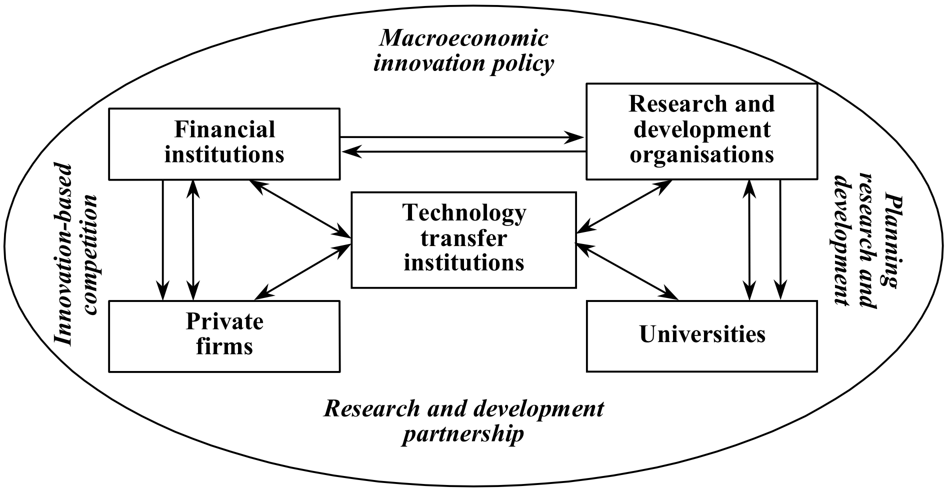

Fig. 1. Main subsystems of the national innovation system and their interlinks[15]

Within the framework of the national innovation system, the government innovation policy supplements market institutions and forms the major rules and conditions for innovation activity, which determine the trends and intensity of relationship among actors of the innovation process, and facilitate the diffusion of knowledge and technology. The innovation policy has a very important role in shaping a favourable environment for innovation development in a country. The national innovation policy would only be efficient if it promotes the innovation capacity of the nation, tested against the criteria of how effectively the NIS functions are carried out.[16] It is necessary to understand that in order to achieve it, all activities within the national innovation system,

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[14] *Fedirko O. A.* Natsionalni innovatsiyni systemy krayin vysokoho konkurentnoho statusu, in Upravlinnia mizhnorodnoyu konkurentnospromozhnistiu v umovakh globalizatsiyi economichnoho rozvytku *(National innovation systems of countries having high competitive status, in international competitiveness management counselling in the conditions of globalization of economic development)*, a monograph in 2 volumes, V. 1, D.G. Lukianenko, A.M. Poruchnyk, L.L. Antoniuk et al.; Ed. by D.G. Lukianenko, A.M. Poruchnyk. — K.: KNEU, 2006. — P. 679.

[15] Created by the author based on: *Ivanov V. V.* Natsionalnye innovatsiynye systemy: opyt formirovaniya I perspektivy razvitiya (*National innovation systems*: building-up experience and development), *Innovatsyi* [Innovations] 2002, Issue 4, p. 16.

[16] *Innovation capacity of the national economy* consists in ensuring a sustainable process of creation, distribution and industrial application of new knowledge and technology based on the unity of the country's research and training potential, financing, information infrastructure for innovation together with industrial clusters within the respective system of government regulation *(author's definition).*

at its every stage, need to be supported by adequate sets of tools and government regulation.

Evolution of Innovation Policy in the Context of the National Innovation System Development

In the 1940-60s the government policy on innovation regulation was not focused on practical application of R&D products in the industry. There were two separate streams of innovation policy: scientific research and industrial innovation policy. Scientific research policy in that period was focused on R&D in universities: accumulation of knowledge, training of researchers, basic research in government R&D organisations. In its turn, industrial policy was preoccupied with the improvement of sectoral organisation of the industry and internal sectoral research by companies.

In the 1970s the difficulties of industrial implementation of research and development projects in large-scale aerospace, telecommunication and nuclear programs have lead to a greater focus on innovation process: it was necessary to integrate R&D and industrial production. With greater globalisation and international competition, the United States' positions on both domestic and international markets have weakened and the United States' share in global R&D expenses has decreased. The U.S. government had to review its traditional approaches to the government's role in creation and dissemination of new technology. The scientific research policy was gradually supplemented by other areas of government regulation, including budget and tax, industrial, infrastructure and social policy, employment regulation, personnel training and use of the workforce. The notion of innovation policy has emerged as a separate comprehensive area of economic policy designed to accelerate the development and industrial implementation of new technology.

The regulatory framework of modern innovation policy is based on the NIS concept which rests on the non-linear model of innovation process. It emerged in the 1980s and had the following distinctive features: expanded set of methods to stimulate innovation activity; new organisational patterns of joint scientific research; greater mobility of scientific brainpower; incentives to invest in industrial and social infrastructure, primarily in the development of information and communication systems.

Almost all industrially developed countries have used the NIS concept, to a lesser or greater extent, as a theoretical basis of their innovation policy due to the general tendency of integration between science and industry. However, the peculiarities of the NIS in individual countries have resulted in the rise of various models of innovation policy with specific accents.

The United States pioneered in revising their legislation. Because the then existing legislation did not meet the requirements of the accelerated industrial implementation of R&D products, the Stevenson-Wydler *Technology Innovation Act* was enacted in 1980. This law established that the priority function of federal scientific laboratories was to transfer the new federally developed technology to state and local government and private sector.[17] The law also provided for the establishment of special organisations within the federal executive agencies to examine and promote industrial innovation, facilitate exchange of scientific and technical personnel among universities, industry and federal laboratories, encourage engagement of private individuals and corporations in scientific and technological development.

Also in 1980, the Bail-Dole Act was passed to encourage scholars, recipients of grants, engineers, and federal laboratories to engage in patented and licensed activity and commercialisation of their research developments. The major stimulus was achieved due to tax incentives and retention of title to inventions resulting from the federal-funded research.

A number of laws were enacted in 1980-90s to encourage inter-company cooperation and expand the ability of government authorities in selling licenses for government inventions. *The Federal Technology Transfer Act* (1986), 1984 and 1993 acts that removed some restrictions on various alliances of corporations for R&D purposes, and tax incentives facilitated the research and development cooperation among companies as well as between the industry and federal research laboratories. Tax incentives (exempting from taxes 80–90 % of profits generated by investment made by private persons and corporations) prompted a proliferation of *R&D partnerships* in the United States. The number of registered R&D partnerships was 665 in 1996 and 830 by the end of 2000.[18] These partnerships were especially popular in the field of electronics and electric equipment (18 %), production of communication equipment (16 %) and transport equipment (15 %).

Bill Clintons' policy initiative titled *Technology for America's Economic Growth* had a great impact on the innovation potential of the U.S. economy. It provided for a consistent implementation of the doctrine of «global technological competitiveness of the United States in conditions of global competition.»[19] This policy initiative underscored that «technological policy begins where science policy ends, and it is not limited only to scientific research and development. It also focuses on prompt implementation of new ideas. The lack of coordinated technological policy is one of the major reasons accounting for

[17] *Farell C., Rebello C., Hoff R.* Rynok venchurnoho kapitala SShA, in *Business Week*, 1996, Issue 3, P. 14—20.

[18] *Science and Engineering Indicators 2002*, National Science Board, Arlington, VA, National Science Foundation, 2002 (NSB-02-1), p. 4—34.

[19] *Chumachenko B., Lavrov K.* Strategicheskoye upravleniye nauchno-technicheskim razvitiyem: opyt SShA, in *Problemy teoriyi in praktiki upravleniya (*Strategic management of scientific and economic development: SShA experience, in *Issues of management theory and practices)*, 2000, Issue. 2, p. 59.

America's lagging behind in turning its research advantages into commercial success and losing technological leadership.»[20]

Japan began to develop a new integrated environment, more favourable to domestic R&D, by enacting the *Science and Technology Basic Law* in 1995.[21] The major efforts aimed at establishing an innovative system which ensures various forms of R&D cooperation such as exchange of R&D personnel, joint R&D activity and joint use of R&D facilities; diffusion of results of R&D through their publication, provision of necessary information on R&D and measures to promote their appropriate practical application; advancement of information processing in science and technology, maintenance of databases on science and technology, construction of information networks among R&D institutions in order to promote R&D efficiency; improvement of research equipment in national research laboratories, logistic support of research in universities and private sector; implementation of a set of measures to promote private sector R&D.

A set of specific implementation measures declared in the *Science and Technology Basic Law* was formulated in the *Science and Technology Basic Plan*[22] (1996) and *White Paper on Science and Technology* (1996). The priority measures included promoting R&D cooperation among universities and industry; securing patent rights of private organisations to the results of joint R&D with government research institutions; and inviting one foreign scientist on average to each unit of government research institutions.

In line with the *Science and Technology Basic Law*, a law was enacted in 1997 to lift restrictions for academic professors on part-time employment (a professor may lead an R&D office in a private company and hold his/her office in a state university). The 2000 law on strengthening industrial technology competency allowed a staff member of a government R&D institution to simultaneously hold a position in a board of directors of a private company which makes practical use of the technology developed by this scientist.

The experience of EU countries in innovation policy development is of particular interest as this integrated alliance is now implementing a strategy of highly integrated international innovation system based on the ERA (*European Research Area*) initiative.

In general the EU innovation policy have passed three stages[23]: (1) period of Euroatom and scientific research in nuclear energy in the framework of the Joint Research Centre (JRC); (2) framework programs on R&D development and pro-

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20 *Androschuk G.* Gosudarstvennoye regulirovaniye peredachi technologii v SShA (Public regulation of technology transfer in the US), in *Business Inform*, 1997, Issue 23-24, p. 19—20.

21 *Prasad B.* Re-engineering life-cycle management of product to achieve global success in the changing marketplace, in *Industrial Management & Data Systems*, 1997, vol. 97, p. 90-98.

22 The Science and Technology Basic Plan of 2 July 1996, Government of Japan, Tokyo, 1996, http://www.cao.go.jp/index-e.html

23 *Borras S.* The Innovation Policy of the European Union: From Government to Governance, Cheltenham (UK), Northampton MA (USA), 2003, p. 12—14, 34—42.

grams to improve Europe's competitiveness; (3) the common European Research Area (ERA) initiative.

The common European R&D cooperation began to develop back in the 1970s. Large-scale international cooperation projects and «great science» sites were implemented and created at that stage. Scientific cooperation at that time had the following typical characteristics: orientated to basic and applied research versus technology developments; reliance on direct government funding and incremental private funding; non-military nature of research; construction of large-scale scientific facilities and laboratories; the nature of political guidance on R&D cooperation was predominantly interstate than superstate.

Such cooperative research organisations as the European Organisation for Nuclear Research, European Molecular Biology Laboratory and European Southern Observatory fully matched the above description in nuclear physics, molecular biology and astronomic research respectively (Fig. 2). At the same time, Airbus and European Space Agency were oriented more towards industrial technology, while the European Scientific Foundation and European R&D cooperation were engaged in multidisciplinary research. And finally, the administration of the Joint Research Centre was supranational in its nature.

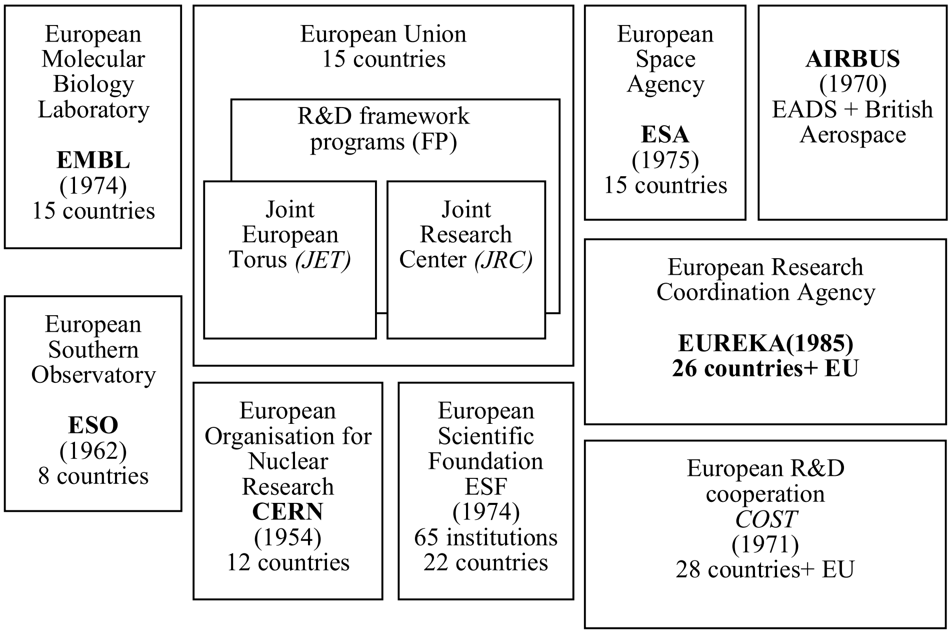

Fig. 2. Institutional architecture
of R&D cooperation in Europe, 2001[24]

In the 1980s, EU framework programs and the European Research Coordination Agency (EUREKA) gave a fresh impetus to international R&D cooperation as they pursued multiyear objectives, embraced most sectors of the economy and had a significantly larger budget. The R&D policy today is the third largest recipient of the EU budget funding. The EU innovation policy is implemented through framework programs which formulate priority areas and funding amounts for specific stages of the innovation cycle (Fig. 3). EU framework programs are largely focused on intensifying international R&D cooperation of member states.[25] The funding for scientific research is complementary, which means that projects are also co-funded from local budgets and private investors or creditors to reduce the risk of total substitution of private funding for R&D. Moreover, framework programs support scientific research only on pre-competitive stages of innovation cycle.

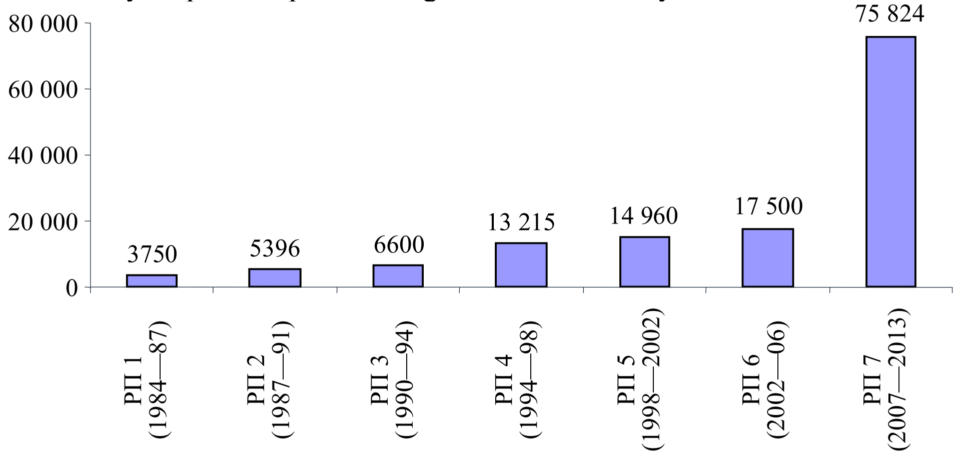

Fig. 3. EU funding for R&D framework programs, million Euros[26]

From 2002 through 2006, the economy of EU countries developed in line with the Sixth Framework Program[27]. Its major objective was to strengthen the coordination of all research and development activities. The program's

24 *Borras S.* The Innovation Policy of the European Union: From Government to Governance, Cheltenham (UK), Northampton MA (USA), 2003, p. 46.

25 It should be noted however that the EU innovation policy is still implemented primarily at the national level. The funding of R&D area by the European Communities is less than 17 % of the total R&D expenditures of EU Member States.

26 *Borras S.* The Innovation Policy of the European Union: From Government to Governance, Cheltenham (UK), Northampton MA (USA), 2003, p. 37

27 Decision No 786/2004/EC Of the European Parliament and of the Council, 21 April 2004. *Official Journal* L 138/7 of 30.4.2004.

priorities include information technology, biotechnology, multifunctional materials, space research, sustainable development, civil society and governance in a knowledge-based society. The Sixth Framework Program embodied the idea of creating an integrated pan European research area which in fact marked a transition to a fundamentally new division of authority between EU and member state governments. The European Union received a new role in the collective production of new scientific knowledge and technology: its sphere becomes much wider and is not limited only to funding of individual projects (as was in the previous Framework Programs) but is rather to accumulate all national resources for the purpose of conducting scientific research and creating innovation nodes with strong synergy effect based on tight interinstitutional links.

The initiative of creating a common European Research Area incorporates three complementary concepts. Firstly, it implies the creation of a common internal market for scientific research, a space for free movement of knowledge, technology and researchers in order to stimulate cooperation and achieve a more effective redistribution of resources. Secondly, it presupposes restructuring of the system of administration of scientific research, especially better coordination of national R&D policies. Thirdly, it involves the development of the European Research Policy which not only ensures the funding of research projects but is also based on a systematic approach, taking into account all aspects of research policy both at the domestic and supranational levels.

In contrast to previous programs, the Seventh Framework Program (2007—2013)[28], which takes into account the needs of the national innovation system and the necessity to improve the competitiveness of the European industry, is not limited to basic research and is more focused on the needs of industry. Funding was significantly increased to ensure that research centres and universities support innovation activity of small and medium-sized enterprises (SMEs). The Seventh Framework Program is implemented in parallel with the Competitiveness and Innovation Framework Program. The latter supports networks which help small and medium-sized enterprises gain access to the Seventh Framework Program (in particular, a project to support innovation business and a project to support innovative SMEs with high growing potential).

The Seventh Framework Program has four priority funding areas[29]:

— encourage R&D cooperation among universities, industries, research centres and public authorities in EU member states and other countries around the world in order to secure the leading positions in key areas of research;

28 Communication from the Commission of the European Communities «Building the ERA of knowledge for growth». COM (2005) 118 final. Brussels, 2005.

29 Ibid.

— facilitate creative research in Europe, carried out by individual groups of researchers, by supporting the newest developments in science, technology, technical engineering, social, economic and humanitarian fields;

— develop human capacity for European research through support of continuous training programs, mobility of researchers, and elevate the attractiveness of research profession; and,

— improve research and innovation competencies within Europe by facilitating innovation infrastructure, research intensive clusters, regional R&D capacity, innovative SMEs, and developing international research policy.

The key objective of the Seventh Framework Program is to converge research policies and measures at the EU level and level of national governments. For that purpose, the Seventh Framework Program implements wide-scale diversified cooperation measures (technology initiatives and European technology platforms) aimed at innovative medicine, nanoelectronics, aeronautics, air traffic management, and environmental safety monitoring.

Today's Mechanisms and Instruments of Innovation Policy

The mechanism of modern innovation policy in the developed countries effectively combines direct and indirect levers of government regulation. Direct methods of innovation support normally take the form of two institutional actions — agency administration and targeted programs. *Agency administration* is implemented as direct and targeted funding. It covers research by government research institutions and laboratories using their own technical and personnel capacities and within strictly defined objectives and nature of implementers' activity. *Targeted programs* are based on contract funding. It provides resources for program implementation not to individual institutions but teams or associations of implementers for specific research projects and programs.

An important from of government support of innovation development in the United States is the *system of federal contracts*, through which 40 % of research projects are implemented. It should be noted that most contracts are made with private companies[30]. Under the *Federal Technology Transfer Act* of 1986, government agencies may enter into *cooperative research and development agreements* with non-government business partners. The law provides that cooperative research and development agreements (CRADAs) for research and development are «any agreements between one or more Federal laboratories and one or more non-Federal parties, under which the Government provides personnel, services, facilities, equipment or other resources (but not funds), and the non-Federal parties provide funds, personnel, ser-

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30 *Androschuk G.* Gosudarstvennoye regulirovaniye peredachi technologii v SShA (Public regulation of technology transfer in the US), in *Business Inform*, 1997, Issue 23-24, p. 19—20.

vices, facilities, equipment or other resources toward the conduct of specified research or development efforts.»[31] According to official reports, 16,819 agreements were made from 1987-1997.

In the late 1980s, the U.S. Congress approved a cooperative *Advanced Technology Program* which was designed to provide grants to companies in order to fund the development and commercialization of high-risk competitive technology. From 1990-2000, 1100 enterprises, non-profit organisations and academic universities participated in the program and received a total of USD3,3 billion (co-funded: 50 % by the government and 50 % by business).[32]

Direct implementation methods of innovation policy also include a targeted government funding of small innovative business through subsidies and grants (Table 1).

Table 1

Government subsidies and grants to venture enterprises[33]

Funding method	Amount	Country
Federal agencies must allocate funding from their budgets to support venture business within an established minimal share	2.5 %	U.S.
Grants for professional training of researchers (in universities, research institutions, and other government or private R&D organisations)	up to 3 years	Germany
Cover expenses for technical assessment of projects, for assessment of possible patenting of R&D results, and for engineering consultations	up to 80 %	Germany
Subsidies to SMEs fir purchasing of assets in order to save power consumption	up to 7.5 % of asset value	Germany
Grants to small enterprises for investment of value of purchased or generated assets in R&D when purchasing patents, movable and immovable property utilized for R&D	up to 20 % of asset value	Germany
Subsidies to small and medium enterprises of extractive and processing industry for purchasing and leasing of computers	25 % of the value of computers (32 % for southern regions of the country)	Italy
Government grants to organisations conducting research under contracts with small and medium enterprises	up to 50 % of expenses for research	France

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31 Science and Engineering Indicators 2002, National Science Board, Arlington, VA, National Science Foundation, 2002 (NSB-02-1), p. 4—35.

32 Ibid, p. 4—36.

33 Compiled by the author based on the European Commission's data-base on innovation policy, *Innovation Policy in Europe: Annual Country Reports*. http://www.trendchart.org/Reports/index.cfm?fuseaction=TrendReports and Poruchnyk A.M., Antoniuk L.L. *Venturnyi kapital: zarubizhnyi dosvid ta problemy stanovlennia v Ukraini (Venture capital: foreign experience and problems of establishment in Ukraine)*, a monograph, Kyiv, KNEU, 2000, p. 76-81.

Funding method	Amount	Country
Subsidies for research of new products or processes for companies with up to 50 employees	75 % of expenses but not more than GBP50,000	U.K.
Reimburse innovation expenses under government programs subsidizing small innovative businesses	up to 50 %.	U.K.
Government subsidies	up to 2 million yen	Japan
Subsidies for industrial research projects	up to 50 % of expenses for wages of research personnel	Canada

Historically, concentration of budget funding in a limited number of large corporations is viewed as an inhibiting factor for R&D. The fact that in the last 75 years individual researchers and small business in the United States accounted for over 50 % of major technical innovation speaks in favor of this trend in innovation policy. Comparing opportunities of small business and large corporations in such sectors as microelectronics, biotechnology and successful commercialization of a large number of promising ideas and inventions, the U.S. government began to take active steps to strengthen their capacity. In the early 1980s, the Manufacturing Extension Partnership was initiated with the key objective to provide consultative and technical assistance to small businesses in achieving compliance with international quality standards. The Small Business Innovation Development Act was adopted in 1982 to expand the financial support for active research and development firms. This statute required that federal agencies should help small businesses obtain government contracts for research and development, including all benefits and privileges. Under this law, 11 federal agencies which finance science were required to allocate 0.2 % of their scientific budget for the Small Business Innovation Research Program (SBIR). In 1989 the compulsory allocation was increased to 1.25 % and from 1992 it increased annually and its rate was 2.5 % as of 1 October 1996. As a result, a modest USD50 million program in 1983 grew up to USD1 billion in the 1997 budget; 55,000 projects were funded during 1983–1999 from the SBIR for the total amount of USD9.7 billion.[34]

The Small Business Technology Transfer Program (STTR) links universities and federally funded R&D centers with small innovation companies for the purpose of commercializing technology. Small business is required to participate in project coordination and perform not less than 40 % of work. The required portion of funding provided by federal agencies was 0.15 % since 1996. 1,700 projects were funded in 1994–1999 for a total amount of over USD300 million.[35]

[34] Science and Engineering Indicators 2002, National Science Board, Arlington, VA, National Science Foundation, 2002 (NSB-02-1), p. 4—38.

[35] Ibid, p. 4—39.

Recently in Japan and in the United States a lot of attention has been paid to involving small and medium business in the innovation process. Right after adopting the law on promotion of new enterprises in 1998, the Japanese government launched a program for innovation research development in small business, similar to the American SBIR program. The program gave small businesses access to government contracts for R&D, subsidies and fiscal incentives which previously were available to only to large companies. Furthermore, Japanese universities will soon be allowed to set up their own science-intensive firms as the possibility to establish 1,000 new companies by 2007 is being discussed today.[36]

The primary role in the world innovation regulatory practice belongs to the system of *indirect methods of innovation stimulation*, where tax policy instruments occupy the key place. Tax credits were first offered to Japanese companies in 1966 and then they were introduced in the United States in 1981. Tax incentives were widely practiced in the 1980s and early 1990s in the majority of development and new industrialized countries in order to encourage companies to set up their own R&D units.

There are two main types of tax credits in developed countries: volume credits and incremental credits (Table 2).

Table 2

Tax credits as a tool to encourage the development of R&D and innovative enterprises[37]

Method	Amount	Country
A portion of increased R&D expenditure compared to average annual R&D expenditure for the three past years related to the main production or commercial activity is deducted from the taxable income	20 % of increased expenditure for R&D	U.S.
A portion of contracted company's expenditures for basic R&D programs implemented by universities is deducted from the taxable income; the cost of research equipment provided by universities and R&D organisations to companies free of charge is deducted from the taxable income	up to 20 % of a company's expenditure for basic research	U.S.
Investment tax credit provides for a reduced profit tax	6 to 10 % of the total value of investment in equipment	U.S.

[36] *Kobayashi S., Okubo Y.* Demand Articulation, a Key Factor in the Reconfiguration of the Present Japanese Science and Technology System, in *Science and Public Policy*, 2003, Issue 1 (February), p. 59.

[37] Composed by the author based on the European Commission's data-base on innovation policy, *Innovation Policy in Europe: Annual Country Reports*. http://www.trendchart.org/Reports/index.cfm?fuseaction=TrendReports and *Poruchnyk A. M., Antoniuk L. L.* Venturnyi kapital: zarubizhnyi dosvid ta problemy stanovlennia v Ukraini *(Venture capital: foreign experience and problems of establishment in Ukraine)*, a monograph. — K.: KNEU, 2000. — P. 76—81.

Method	Amount	Country
For a certain period of time, tax credit applies to net investment made after 13.03.2001 in material and non-material assets	8 to 65 % of net investment depending on a company's size and location	Italy
A portion of R&D expenditure in the current year is deducted from the taxable income, not to exceed the average R&D expenditure for the past two years, in fixed prices (not more than EUR6.1 million per one enterprise)	50 % of increased expenditure for R&D	France
A portion of increased R&D expenditure is deducted from the taxable income.	20 % of increased expenditure for R&D	Japan
Tax credit to reimburse a portion of capital and carrying expenditures for R&D to a company depending on the size and location of the corporation	10 to 25 % of capital and operating/current expenditures for R&D	Canada

Volume tax credits provide a credit proportional to expenditures. In this case, a company is able to decrease the total taxable income by a legislatively fixed percentage of its money spent for R&D. The highest tax credit rate of this type is applied in Australia (150 %) and Singapore (200 %). In the Netherlands, volume credits apply only to the sums paid as salaries to scientists and engineers engaged in R&D. In France, tax credits amount to 25 % of a company's total expenditures related to personnel training programs.[38]

Incremental tax credits are based on a company's increased R&D expenditures compared against the same type of expenditure for the base period (previous year or an average figure for the previous 3 to 5 years). In this case, a company's tax payments are reduced at a fixed percentage for every monetary unit of increased R&D expenditure in the current period. The maximum incremental tax credit rate of 50 % applies in France, and it is only 20 % in Canada, the United States and Japan[39]. A combination of these two incentives is possible but they apply to different expenditure types. Therefore, the total incremented credit in the United States is supplemented by a volume credit of 20 % applied to private sector expenditures for basic research.

Besides tax credits, a widely applied tool are also reduced tax rates for innovative enterprises (Table 3).

Table 3

[38] *Ivanova N.* Finansovye mekhanizamy nauchno-tekhnicheskoy politiki (opyt stran Zapada) (Financial mechanisms of scientific and technical policy (experience of Western countries)), in *Problemy teorii i praktiki upravlenia (Issues of management theory and practices)*, 1997, Issue 5, p. 78—83.

[39] Ibid.

Tax credits and accelerated depreciation for innovative companies[40]

Method	Amount	Country
Partial income tax exemption for R&D expenditure: for SMEs which expend over 50,000 pounds (80,500 Euros) per year; for large companies	150 % of R&D expenditure; 125 % of R&D expenditure	U.K.
Partial income tax exemption for transaction involving venture securities	60 %	U.S.
Tax credits for private investment in R&D	up to 7,5 %	Germany
Partial income tax exemption for increased current «qualifying» investment compared to the average investment in the past five years. Qualifying is investment in development of new capacities, purchase of equipment, devises and machinery, completion of suspended projects, company expansion and retrofitting, purchase of tangible and intangible technology	50 % of increased «qualifying» investment	Italy
Partial income tax exemption for R&D expenditure during a year. Full income tax exemption if research results cannot be practically implemented within one year	50 %; 100 %	Italy
Tax credits applied to the cost of advanced technology purchased by companies with over 100 personnel	up to 25 % of investment	Italy
Partial income tax exemption for purchase of services facilitating the acquiring of new technology	up to 40-50 % depending on the company size	Italy
Favourable income tax rate for new companies for 3 years	25 %	France
Reduced income tax for venture firms	35 % to 25 %.	U.K.
Reduced income tax for SMEs and private individuals under the Venture Trust Capital mechanism.	by 20 % but not more than 100,000 pounds (156,300 Euros) per year	U.K.

[40] Composed by the author based on the European Commission's data-base on innovation policy, *Innovation Policy in Europe: Annual Country Reports*. http://www.trendchart.org/Reports/index.cfm?fuseaction=TrendReports and *Poruchnyk A. M., Antoniuk L. L.* Venturnyi kapital: zarubizhnyi dosvid ta problemy stanovlennia v Ukraini *(Venture capital: foreign experience and problems of establishment v in Ukraine)*, a monograph. — K.: KNEU, 2000. — P. 76—81.

Method	Amount	Country
SMEs and private individuals are partially exempted from income tax on capital increase/gain and dividend tax under the Venture Capital Trust scheme,	not more than 100,000 pounds (156,300 Euro) per year when buying shares in venture funds.	U.K.
Under the Enterprise Investment scheme, investors in shares of small venture firms (whose assets value does not exceed 15 million pounds before investment and 16 million pounds immediately after investment) are eligible for: income tax relief on the amount invested , and relief from capital gains tax on disposal of the shares	by 20 % (but not more than 150,000 pounds per year) and 20 % respectively.	U.K.
Reduced profit tax for venture companies	42 % to 30 %	Japan
Reduced profit tax to employees investing in venture capital	by 15 %	Canada
A portion of increased capital assets is exempt from profit tax	50 % of increased capital assets	Canada
No tax on the lease of venture firms	0 %	U.S.
No taxes for the legally defined risk capital	0 %	U.S.
Tax exempt money invested in venture projects	0 %	France
No profit tax on sales of securities or reinvested assets	0 %	Canada
Accelerated depreciation: reduced in-service life of equipment for venture firms	up to 3 years, and up to 5 years for other trusts.	U.S.
Accelerated depreciation: a portion of capital asset value above the normal depreciation rate may be depreciated during re-equipment	45 % of capital asset value (15 % per year) during 3 years after the purchase.	Italy
R&D expenditure may be included in the product cost	any amount	U.K.
Science intensive enterprises may write off a portion of the machinery, equipment and construction facilities cost in the first year of their operation	30 % of machinery and equipment cost;	Japan

Method	Amount	Country
	15 % of construction facilities cost	

In the United Kingdom, the profit tax rate is 29 % for small an medium companies and 25 % for venture firms (standard rate is 35 %). In Japan, the profit tax for venture companies is 30 % (standard rate is 42 %). In Germany, the tax credit for R&D investment is 7.5 %. In France, profit tax credit for new companies is 25 % for three years. In the United States, the legally established risk capital is fully exempt from taxation and there is no tax for the lease of venture firms. In France, investment in venture projects is tax exempt. In Canada, profits from the sale of securities or reinvestment assets are tax exempt.

In 2004 in France, the Innovation Plan was launched, which comprises a number of steps aimed at encouraging innovation and development of creative entrepreneurship. The newly established small science-intensive enterprises with significant investment in R&D are provided a number tax incentives, such as exemption from compulsory social payments, company tax, tax on advanced shares held over 3 years, and a number of local taxes and dues. In Great Britain, the taxable income of small and medium enterprises which spend not less than 50,000 pounds for R&D per year is reduced by 150 % from 2000 and the same credit applies also to large companies (125 % of R&D expenditure) from 2002. Furthermore, in April 2002, tax credit was approved for small R&D enterprises, the list of works classified as R&D was expanded, and some 40 rules regulating R&D companies were abolished. Tax credits apply to 4,500 companies with not more than 250 employees and annual sales not below 25 million pounds (40 million Euros), and annual R&D expenditures over 25,000 pounds. Their share of R&D expenditures in the private sector is approximately 10 %.

Depreciation expenses are a major source of capital used by companies for R&D and re-equipment in addition to profits. Developed countries make innovative companies eligible for *accelerated depreciation* of capital assets which increases the turnover of such assets and encourages innovation. France, Italy and Germany allow writing off up to 50 % of the cost of equipment and immovable items of capital assets in the first year of operation. In Japan, R&D companies write off 30 % of machinery and equipment costs and up to 15 % of construction facilities costs in the first year of their operation.

The overview of the innovation policy mechanisms in developed countries allows us to conclude a general trend towards an optimum balance of direct budget funding and a system of tax credits. The efficacy of such an approach is demonstrated by the fact that the private business, which accounted for 63 % of R&D funding in the OECD countries in 2001, is nowadays a major source of R&D funding in developed countries.

Conclusions

The post-industrial stage of the world's economy sets new benchmarks and criteria of efficient national models of economic development. The social and economic progress is now more dependent on the ability of economic systems to ensure a continuous creation and industrial implementation of new technology. Tougher international competition, amplifying global competitive environment, and involvement of all countries in the international labour distribution push the governments to seek strategic competitive advantages. This raises the importance of targeted government support of innovation that ensures long-term advantages based on technology innovation.

Globalisation and informatisation of international economic relations and intensification of international competition have transformed not only the R&D policy of countries but also the methodology of innovation research. The concept of national innovation systems has become the core of innovation policies in major countries of the world, guiding them towards the integration of education, science, industry and capital.

The national innovation system is a combination of organisations and mechanisms which set out the conditions for the creation, accumulation, dissemination and industrial application of scientific and technical knowledge in a country. Therefore, the overall innovative efficacy of the economy depends not only on the efficiency of individual innovative players but also on the character and intensity of their interaction in the course of creation and dissemination of new knowledge and the mechanism of innovation management. Interaction of industries, universities and public research organisations, cooperation of private companies in research and development, dissemination of highly productive technology in the work of small and medium businesses, mobility of personnel between the public and private sectors are of crucial importance for innovative development of economy.

World experience strongly indicates that an efficient and diversified innovative policy, prompt rollout of a system of technology mediators, and a funding mechanism for innovative development of the economy based on a combination of significant private R&D funding and a wide system of government incentives for innovation are the universal factors that significantly increase the innovative capacity of developed countries. It should also be noted that government regulation of innovation is not limited to the compensation of possible market gaps but rather goes ahead of the private sector by setting technology priorities, forming a powerful internationalised infrastructure for commercialisation of the intellectual potential, increasing the mutual interest of business and government R&D and educational organisations to cooperation in development and industrial use of unique technology.

The profound changes in today's concept of innovation management prompt the need for a systemic reform of the approach to innovation incentives in Ukraine. Significant enhancement of incentives for innovative companies, government funding and tax credits to develop the infrastructure that supports innovation, improved regulation that ensures the development of venture capital and R&D entrepreneurship, encouragement of high-tech clusters based on leading universities and strategic enterprises in mechanical engineering and chemical, information technology and communication, software, finance, insurance, high-tech medicine, etc. should be the key directions along which the national innovation policy should be improved.

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The article was received by the editorial board on 07.02.2007